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Using Collective Intelligence to identify barriers to implementing and sustaining effective Fundamental Movement Skill interventions: A rationale and application example

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Abstract

To have population-level impact, interventions must be effectively implemented and sustained under real-world conditions. Few Fundamental Movement Skill (FMS) interventions are implemented at scale, and even fewer are sustained in a way that allows for ongoing evaluation of population-level impacts. There has been increasing recognition of applying systems thinking to investigate the multitude of influences on interventions. To improve research-practice translations, investigations need to incorporate synthesised perspective and collective input from intervention stakeholders. This study trials Collective Intelligence (CI)—an applied systems science approach—to understand barriers to the adoption, implementation and institutionalisation of effective FMS interventions for children and adolescents. Participants generated a structural map to guide future action mapping, as a result of the CI session. By presenting this application example, we aim to underline the considerations and alleviate barriers to conducting much needed implementation and sustainability studies in FMS interventions. CI presents a new method to add to the 'tool box' to understand the complexity and functioning of public health interventions, such as those targeting physical activity behaviours.

Keywords: Motor Skills; Child; Adolescent; Implementation Science; Systems Science

Introduction

Fundamental Movement Skill (FMS) are the "building blocks" of more advanced, complex movements required to participate in sports, games, or other context specific physical activity (PA) (Logan et al. 2018). Enhancing children's FMS proficiency is recommended by the World Health Organisation (WHO) to establish a foundation for lifelong PA engagement (WHO 2019), given the reciprocal and developmentally dynamic relationship between FMS and PA (Stodden et al. 2008, Robinson et al. 2015). FMS is also important as a health outcome in its own right as it is associated with a range of health benefits including physiological benefits (e.g. healthy weight status) and psychological benefits (e.g. increased perceived physical competence) (Lubans et al. 2010, Barnett et al. 2016, Cattuzzo et al. 2016). Therefore, it is not surprising that FMS has been the focus of numerous health interventions for children that synergistically target PA participation. The immediate effectiveness of FMS interventions have been reported extensively and are mainly established through controlled trials (Eddy et al. 2019, Morgan et al. 2013), yet children's FMS competence levels still remain low (Barnett et al. 2016, Robinson et al. 2015, Bardid et al. 2015, Bryant, Duncan, and Birch 2014). This denotes that very few efficacious interventions move from research to practice to extend the population health impact, and even rarely do they provide information on implementation and sustainability (Koorts et al. 2018).

Implementation is defined as the process of integrating an intervention into practice within a particular setting (Milat, Bauman, and Redman 2015). Sustainability is the continued implementation of programme components for the continued achievement of desirable

programme and population outcomes (Scheirer and Dearing 2011). Implementing and sustaining interventions is challenging yet feasible (Rabin et al. 2006); a review on sustained intervention effects on PA, fitness and FMS revealed that with theory-informed intervention design and sufficient dose, FMS and PA are likely to be sustained outcomes in children and adolescents (Lai et al. 2014). The review attributed the lack of sustainability to the absence of research planning for sustained programme implementation and assessment. Nevertheless, there are copious theoretical frameworks available to guide researchers for implementation and sustainability of health interventions (e.g. RE-AIM, Ecological framework) (Nilsen 2015). A review on physical activity and sedentary behaviour trials (which included some FMS trials) reported that even among the limited intervention trials that utilised implementation theories, the widespread seemingly ad hoc application of implementation models signifies that implementation and sustainability are not considered by researchers across the intervention life cycle (Cassar et al. 2019). This is likely partially due to researchers insufficient knowledge and appreciation of real-world research methodologies (Koorts et al. 2020). By the same token, adopters and users in the real-world sometimes find interventions incompatible with their routine practices owing to the need for understanding of intervention functioning (Glasgow, Lichtenstein, and Marcus 2003). This continued inadequate collective understanding of the issues in an intervention faced by both researchers and end-users (Bopp, Saunders, and Lattimore 2013) makes addressing implementation and sustainability in FMS intervention research a significant priority.

The challenges of planning for implementation and sustainability are grounded in complex interactions between interventions, practice settings, and a broader ecological system (Chambers, Glasgow, and Stange 2013). This is of particular relevance for FMS interventions targeting children and adolescents, since intervention settings are often schools

where various agents and factors operating at individual, organisational, and system levels moderate the intervention process and outcome (Cassar et al. 2019). Furthermore, these elements are not to be considered in isolation due to their interactive and dynamic nature (Littlecott et al. 2019). The complex nature of FMS interventions (and many other health interventions) requires researchers to view interventions as 'events' within complex systems (Hawe 2015), where a range of characteristics of interventions can be examined to understand what works and will continue to work, for whom and under what circumstances (Moore et al. 2019). As such, it is essential that investigations in FMS interventions account for multifaceted contextual challenges and understand what ingredients make intervention implementation sustainable – ingredients which can be further compiled and translated into measurable indicators to show the progress of implementation (McKay et al. 2019).

Increasing awareness of the complexity and multitude of influences on interventions has put a spotlight on systems modelling as a means of understanding intervention scenarios and dynamics. A recent WHO bulletin commissioned by a group of experts advocate that the application of systems thinking can demonstrate the interconnectedness of key components in PA research (Rutter et al. 2019). As yet, there is limited awareness on how modelling approaches can be integrated to advance understanding of intervention functioning in the field of FMS or PA research. The nascent application of systems thinking are predominantly in community-based obesity preventions where techniques such as network analysis and agent-based modelling are utilised to visualise the dynamic complexity of a system (Bagnall et al. 2019, Hayward et al. 2020). In the field of FMS or PA research, this could be utilised to investigate how interventions potentially reshape the system (Rutter et al., 2019), which may include analysis of systems of barriers that constrain intervention success. This could be beneficial if implemented to facilitate contextual understanding of intervention system

scenarios, and pathways to improve intervention design and evaluation that ultimately uphold intervention implementation and sustainability success. Such practice could yield substantial information if incorporated in a collaborative research context working with a team who have a stake in implementation and sustainability of an intervention, such as researchers, practitioners (e.g. teachers), and beneficiaries (e.g. students) (Johnson et al. 2019).

This paper reports on the initial testing of an applied systems science approach – Collective Intelligence (CI), designed to facilitate systems thinking and collective problem-solving relevant to FMS intervention implementation and sustainability. By illustrating the rationale and utility of CI methodology and presenting a case example of applying CI, we will (a) show why CI is a potentially valuable approach in the context of FMS intervention research and (b) provide future directions of where CI will be beneficial.

Methods

CI aims to generate, clarify, and structure interdependencies between problem elements, and further develop options to address the system of interdependent problems (Warfield and Cárdenas, 1993; see Groarke and Hogan, 2016; Hogan et al. 2015c; RezaeiZadeh et al. 2017 for recent social science applications; and see Hogan et al. 2014, 2015a, 2015b for further details on methodology and application). It utilises a set of methodologies to understand a complex issue and to map actions in response to a problem field by integrating inputs from individuals with diverse views and perspectives in the context of a facilitated and computer-supported workshop structure (Warfield, 2006).

To facilitate the CI process, the facilitation team derives a systems model from group member's reasoning and consensus-based voting on problem relations using a computer-

supported methodology, *Interpretive Structural Modelling* (ISM; Warfield and Cárdenas, 1993). Using ISM, group members collaboratively construct a structural map to illustrate the interdependencies between problems in a problem field. The structural map provides a launch pad for the group to conduct action mapping to solve the problem in an efficient manner, focusing on logical interdependencies between problems and designing actions that help to address key drivers of negative influence.

CI is a context free tool that can be applied in any complex situation (Janes and Milee, 1998). It was validated using Structural Equation Modelling (SEM) for its function of group decision making (Chang 2010). In the field of health sciences, CI has been applied to identify challenges in improving health and wellbeing for Irish citizens (Hogan et al, 2015c) and for the design of personalised nutrition services for older adults in Europe (Hogan, Harney and Walsh, 2017). In the context of FMS interventions, CI offers a potential way for stakeholders, researchers, and leaders to reach consensus as regards the nature of the problems they face in implementing and sustaining interventions and solutions to address these problems. We envisage CI to be added into the 'tool box' of methods to address research and practice challenges in the early stage of the intervention life cycle and in planning to address barriers to intervention implementation.

The operationalisation of CI involves four stages, summarised in Figure 1.

Insert Figure 1 here*

The first stage involves individual barrier generation. In Stage 2, all barriers are categorised by the CI facilitation team prior to the CI workshop. Stage 3 involves a closed voting process and structuring selected barriers using ISM software during the CI workshop (Broome and

Hogan, 2012). This workshop process is visually described in Figure 2. The four steps of ISM are: (i) identification and clarification of a 'relational question' for exploring relationships among the barriers generated in the previous stage; (ii) using the relational question to explore connections between pairs of ideas, the software presents 2 barriers each time for pair-wise relational mapping. The group engages in reasoning on each relational question and a vote is taken to determine the group's judgement about the relationship. A "yes" vote is entered in the ISM software (and coded as '1' in the underlying matrix) only if a majority consensus (>=70%) is reached, otherwise, a "no" vote (0) is entered; (iii) graphical display of full matrix of decisions and group interpretation of the structural model and amendment to the model by the group, if needed. The structural map generated is a representation of how barriers are related. The facilitators remain impartial and only facilitate member's reasoning and communication.

Insert Figure 2 here*

In Stage 4, participants engage in a process of generating options for overcoming the barriers. The idea writing (Warfield and Cárdenas, 1993) technique is used. This technique involves five steps: (i) presentation of a stimulus question to the group (e.g. what are options for overcoming the barriers in the category [x]?); (ii) silent generation of ideas in writing by each member working alone; (iii) exchange of written sheets of ideas among all members in a group, with opportunity for individuals to add ideas as they read others'; (iv) discussion and clarification of ideas; (iv) an oral presentation of the ideas generated and prioritised as most

impactful by the working group. When generating solutions, action plans are aimed at resolving problems in a logical and orderly manner according to the structural map.

A Case for Using Collective Intelligence in FMS research

This section identifies how CI is operationalised and what outcomes CI can generate in investigating issues in FMS research by presenting a case example from a pilot study. In this study, CI was employed to (a) elicit expert perspectives on the barriers associated with the implementation and sustainability of FMS interventions, (b) map interdependencies between these barriers, and (c) generate solutions to overcome barriers.

Methods of the Pilot Study

Participants

20 researchers/practitioners in the United Kingdom and Ireland who have designed/implemented/evaluated FMS interventions (identified through peer reviewed publications) were invited to participate. They were considered to have specialised knowledge and a stake in the issues related to FMS intervention implementation and sustainability. For pragmatic purposes of this pilot study, wider stakeholders (e.g. teachers, parents) were not recruited. These wider stakeholders will be included in future CI applications. Nevertheless, among researchers included, some can provide insights into broader stakeholder perspectives given their diverse roles and experience (e.g. some researchers were previously PE teachers) and this information was prompted in each stage of CI. Table 1 provides a summary of perspectives the recruited participants represent.

Insert Table 1 here

Procedure

In Stage 1, all 20 participants were invited to generate five barrier statements in response to the following triggering question: *"From your understanding and previous involvement in FMS interventions, what do you consider are the key barriers to the adoption, implementation and institutionalisation of effective FMS interventions targeting children?"* A number of starter phrases (e.g. failure to, lack of, conflicts between) were provided to facilitate barrier generation. In Stage 2, the CI facilitation team (JM and MH) collated all responses and performed a paired comparison with all the barriers to find commonalities and create categories. Barriers were categorised based on similarity of the ideas expressed in barrier statements. In Stage 3, from the 20 initial participants, five were invited (due to availability) to take part and form the panel of experts in the CI workshop. After the introductory presentation on the CI workshop goals and overview of categorised barriers, the panel of experts were asked to (a) review the barriers arrayed on display walls and handouts so that each member of the panel had a clear understanding of the barriers, and (b) use a voting method to select the most critical barriers across all categories. Each member was given votes to cast on the barriers that they identified as most critical, and a set of ten barriers which had the most votes were selected for structuring and entered into the ISM software. Given our focus on examining interdependencies between barriers to the implementation and sustainability of FMS interventions, we focused on aggravation relations, specifically, by asking the following question: "*In the context of the adoption, implementation and*

institutionalisation of effective FMS interventions, does barrier A significantly aggravate barrier B?". In Stage 4, participants focused on the generation of options for barriers as informed by the structural map.

Results of the Pilot Study

A total of 58 barriers were generated in response to the trigger question. These were organised into 13 barrier categories (see Figure 3, and Appendix 1 in supplementary materials for the full set of barriers).

Insert Figure 3 here

In Stage 3, participants generated a structural map (Figure 4) describing the system of relationships between the ten critical barriers. As shown in the Figure 4, participants argued that 'Refusal of government to offer greater time for PE and sport in schools' is a fundamental driver in the system.

Insert Figure 4 here

As informed by the structural map (Figure 4), participants focused on the generation of options for barriers in the Category [B. *Government and Institutional*] and [C. *Curricular Conflicts*] given that selected critical barriers in these categories are seen to drive the system of interdependent barriers. Overcoming these barriers is thus likely to increase our chances of resolving all other barriers in the system and ultimately, improving implementation and sustainability of FMS interventions. Table 2 gives an example of options the group generated

252 in response to the barriers in the categories. The full set of options generated is provided in
253 Appendix 2 in supplementary materials.

254

255 ***Insert Table 2 here***

256 **Discussion**

257 Challenges and recommendations to improve intervention implementation and sustainability
258 are well documented (Cassar et al 2019, Koorts et al 2019). The current piece of work
259 highlights the utility of the CI methodology to understand and address implementation and
260 sustainability challenges in the context of FMS intervention research. In particular, CI assisted
261 in our understanding of barriers to the adoption, implementation and institutionalisation of
262 effective FMS interventions, and identifying options and potential solutions to improve and
263 sustain the intervention implementation and effectiveness.

264 Building upon previous studies eliciting stakeholder perspectives on barriers (e.g.
265 Koorts et al., 2020), CI outcomes reveal both the barriers to improving implementation and
266 sustainability of FMS interventions and how these barriers influence each other, as
267 represented in a structural map that captures the consensus-based logic of stakeholders. The
268 illustrative case example showed that CI assisted in identifying barriers in the problem field
269 and provided a model describing interdependencies between problems (Figure 4),
270 highlighting the aggravating influence of both Government and Institutional and Curricular
271 Conflict barriers on all other barriers, and providing a system of logic for the panel experts to
272 design solutions accordingly (Table 2). The pilot results are suggestive, and barriers and
273 interdependencies may be replicated in other scenarios. For instance, the case illustrated
274 here will be applied with different FMS intervention teams to tackle the issue in more depth

and provide context-specific CI supporting intervention implementation and sustainability across the UK and Ireland. FMS are fundamental to population health and lifespan physical development, and broad stakeholder engagement and ongoing systems thinking addressing barriers will be critical for sustainable intervention success in the future.

This system-based understanding of the barrier field and potential solutions in response to the system of barriers are drawn from the multi-disciplinary expertise of the participants and their collaboration during the workshop. In the context of this pilot study, participants underwent the CI process and developed the collective understanding of the problem and identified priorities in resolving the problem, prompting the systematic generation of potentially impactful and feasible solutions matched to the complexity of the problem. As such, gaining knowledge on the intervention levers likely to have the most impact and appreciating the complex barrier system in which interventions are implemented will increase the likelihood of successful implementation (Rabin et al. 2006). CI can also be used to generate prioritisation structures that can potentially inform evidence-based implementation evaluation (i.e., where ISM is used to construct a consensus-based systems model describing how options support one another). If CI is conducted in the early planning of an intervention, structuring potential barriers, options, or indeed intervention activities, it could potentially help identify drivers of intervention functioning and clarification of key evaluation dimensions. In this way, researchers could propose and devise measuring variables that can track and predict implementation and sustainability in early planning (McKay et al., 2019, Koorts et al., 2019). Engaging in this systems thinking and planning work early on is also recommended as it is in the interest of funders and practitioners to understand whether the planned investment is sufficient to sustain long-term intervention implementation and improved health outcomes (Wolfenden et al. 2019). The hypothetical pathways and benefits

299 described here will need to be further tested and evidenced in future CI applications, in order
300 to see if CI does, in fact, address the gap between research to practice.

301 The application of CI aims to engage a group of participants in a democratic, consensus
302 building process (e.g. voting, modelling structural relations collectively) which can enhance
303 the legitimacy of decision-making (Hogan, Hall and Harney, 2017). While alternative
304 computer-mediated system modelling approaches such as 'STICKE' (Hayward et al. 2020) is
305 also purposed to demonstrate stakeholders' interests and perspectives, they do so in a
306 different manner by inviting participants to contribute to the modelling independently and
307 remotely. CI is designed to maximise the potential of group work by integrating and organising
308 the knowledge, experience, and reasoning of participants with a range of diverse
309 backgrounds, perspectives, and values. When used with multiple groups addressing a
310 common societal challenge, one of the key outcomes of CI work—a structural map generated
311 from a standardised real-time modelling process—also allows for CI meta-analysis of multiple
312 models to be conducted (Fauville et al 2018). Also, the structural maps generated with
313 collective qualitative, deliberative input can potentially be tested quantitatively as they
314 describe casual pathways between intervention levers.

315 As the first use of CI in FMS research, there are further considerations in its future
316 applications. For the pragmatic purpose of this pilot, convenience sampling focused on FMS
317 researchers was used. In the current application, five participants who engaged in the CI
318 workshop all come from the same institution. Although they underwent familiarisation and
319 iterative reviews of barrier categories generated by the initial group of 20 researchers, their
320 established working relationship and shared values could introduce bias into their collective
321 understanding of the problem. This issue was addressed during the workshop through careful

facilitation and creation of an environment conducive to learning, reflective thinking, and sharing diverse views (Hogan and Broome 2019). In the future application of CI, representative stakeholder sampling should be applied to reduce potential biases and to expand stakeholder engagement such that PE teachers, school administrators, parents, leaders and funders are included. This will increase the scale and depth of stakeholder co-production and bring to light additional practical considerations in research translation efforts that can enhance the application of proposed actions (Estabrooks and Glasgow 2006). Additionally, CI can be combined with scenario-based design (Hogan, Harney & Hall, 2017), which further refines participants' thinking in relation to specific intervention scenarios such that proposed options can be translated into tangible, concrete and specific design solutions that are consistent with stakeholder needs and preferences.

Conclusion

This study is the first to apply CI in the field of FMS research. The complex characteristics of implementation settings and understanding the interdependent influencing factors that act as barriers to FMS intervention success are key challenges researchers face when translating evidence-based interventions to practice. Those who are interested in translating interventions into sustained practice are encouraged to use the CI methodology detailed in this paper to inform and operationalise their work. This methodology is also relevant for researchers to integrate consideration of implementation and sustainability into the life span of an intervention (planning, design, delivery and evaluation) in efforts to support best practice in the translation of research evidence into practice.

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Supplementary materials

Appendix 1 Full set of categorised barriers

A. Time

1. Shortage of time in teaching staff and primary care providers
2. An insufficient amount of time afforded to us in school setting
3. A demand for time in the curriculum, impacting time allotted for interventions

B. Government and Institutional

1. Shortage of political support (school, local government) for FMS interventions
2. A lack of institutional structures to incorporate programmes sustainability
3. Refusal of government to offer greater time for PE/sport in schools

C. Curricular conflicts

1. Failure to emphasise the importance of FMS/PA to the level of academic achievement in subjects such as Maths and English
2. Conflicts between PE and major prioritised English and Maths curriculum
3. PE competing with demand from core subjects for curricular time
4. Interference between intervention goals and staff goals (short-term)
5. Conflict between school targets and research targets

D. Design and Implementation

1. Working around school's schedules for testing and focus groups was difficult
2. Inadequate preparation by PE teachers in advance of the lessons(s) to bring about meaningful change
3. Inadequate interventions are implemented (e.g. to focus on specific skills for boys and girls)
4. Interference from external sources (i.e. matches, exams, field trips) leading teachers and/or students missing lessons and lack of continuity in the delivery of the intervention
5. Failure to realise a one size fits all intervention does not work for everyone
6. Failure to keep contact with head teacher or stakeholder

E. Research challenges

1. Failure to recruit schools/children to interventions
2. Lack of honest from participants in their completion of Perceived Motor Competence data forms
3. Challenging to manage the number of schools involved
4. Difficulty in obtaining research teams to attend schools

5. Large volume of data to be scored which was very time consuming
6. Conflict between monitoring fidelity and allowing the project to stand alone as it would have to in practice

F. Knowledge and Appreciation

1. Unwillingness of parents/carers to participate/interact with projects/interventions
2. Inadequate appreciation for Professional Learning or FMS from the teaching staff
3. Lack of teacher knowledge of FMS and PA in children
4. Lack of awareness of effective interventions amongst professionals and practitioners
5. Lack of stakeholders knowledge and understanding concerning the benefits for children development derived by FMS interventions

G. Conflicts and purposes within PE

1. Shortage of pedagogical emphasis on improving Perceived Motor Competence on its own in the intervention
2. Lack of clarity from a subject perspective around what the results mean
3. Potential conflict within the aims of PE and therefore what it should be fulfilling (long-term)
4. Lack of PE assessment
5. Conflicting interpretations among PE teachers of the aims and the purpose of FMS interventions
6. Conflicting between performance testing and basic movement testing, in high performance environments

H. Resources and Funding

1. Inadequate resources within schools
2. Personnel and monetary cost to analysing and implementing results
3. Shortage of school resources and time
4. A constantly shifting funding environment meaning new money is always being chased
5. Inadequate funding to make interventions sustainable
6. Lack of funding to support implementation phase
7. Conflict between different projects using the same space in the school
8. Cost of necessary equipment

I. Staffing

1. Shortage of staff to support interventions, therefore prevents the 'adoption' of an intervention going forward

2. Lack of PE teacher or trained expert working in the school continuously
3. Lack of confident and skilled generalist classroom teachers
4. A high staff turnover

J. Efficacy and attitude

1. Resistance to change (PE teachers)
2. Unwillingness by PE teachers to implement strategies that they are not familiar with
3. Lack of confidence continue to adopt elements of interventions once researchers have left

K. Training

1. Lack of initial training and Continuing Professional Development (Interventions seen as 'specialist' by teachers and as some already lack confidence to deliver curricular PE)
2. Lack of Continuing Professional Development for PE teachers (i.e. minimal contact time with PE teachers) and therefore inadequate training
3. Inadequate subject knowledge within PE if to be implemented by school staff
4. We as researchers can implement the intervention but key to me is that the practitioners (teachers) need to be involved in the delivery, their time and expertise doesn't always allow for this though
5. Lack of insufficient training of people providing FMS sessions

L. Testing challenges

1. Interference of skill performance from one student to the next- i.e. Students occasionally mimic performance of other class members resulting in similar criteria being failed
2. Failure of test subjects to engage with demonstration from researchers

M. Intervention efficacy

1. Lack of evaluation to evidence intervention efficacy
2. Lack of interventions effectiveness evaluation in terms of their frequency and duration (weeks), and follow-up on their effectiveness

Appendix 2 Full set of options

1.Curricular Conflicts

Establish the significance/importance of PE as a core subject

Encourage PE curriculum development and its importance

Demand programme reports from PE and assessment in PE

Promote similarities between intervention goals and staff goals

Identify shared goals between schools and researchers

Promote movement opportunities throughout the whole school day so it is embedded through educating staff/sharing practice of good examples

Demonstrate a holistic benefit of implementing a movement-based curriculum to drive change

Develop a school movement plan/policy to cover curricular and co-curricular, active transport and homework

Design intervention goals to be measurable by staff and relate their goals

Conduct research to drive information/knowledge around the measurable goals to achieve a whole of objectives

Create common research and school goals/targets

Change school ethos around PE and school mission/values

Promote the importance of PE/FMS/PA

Encourage schools to recognise the need for PE to be a core subject, allowing sufficient time for interventions

Audit space use and plan/organise/develop ways to use staff/resources/space more effectively

Encourage explorations of a variety of spaces/environments

Promote awareness/understanding/education of FMS and its impacts it can have on core subjects e.g. language, cognition, social skills

Change school targets based on scientific evidence

Develop sustainable interventions co-designed between teaching staff and researchers so goals are shared, achievable, sustainable and feasible

Establish a working group to organise the evidence base to inform step 2 and 3

Develop evidence-based framework and identify areas of future research to build further base

Develop policy and promote, implement and evaluate it

Build evidence base for the importance of PE/FMS in children for lifelong health to inform policies

To refine school policies in light of the shared values, ethos and goals through observations, auditing and evaluating

To understand school values and ethos to drive shared goals and promote them

2. Government and institutional options

Demand policy development to increase the significance of PE in schools

Establish policy frameworks associated with measurable outcomes (evaluation technique)

Educate policy holders on the importance by evidence-based practice drawn from high quality interventions/evaluations which have all stakeholder input (shared/collective knowledge)

Encourage recognition of PE and FMS importance by government at national and local level

Create resources e.g. FMS guidelines/assessments from evidence base which can be embedded into PE curriculum policy

Set up a task force –multi –education, health to develop, implement and evaluate policy

Promote the evidence/findings from the above task force to change government level policies

Build evidence for potential support provision of time for PE and FMS

Encourage all stakeholders to promote the evidence base to policy holders through impact. E.g. working group

Demand better training for teachers to ensure better structures for intervention sustainability are achieved

Organise appropriate CPD/days to incorporate appropriate teaching training

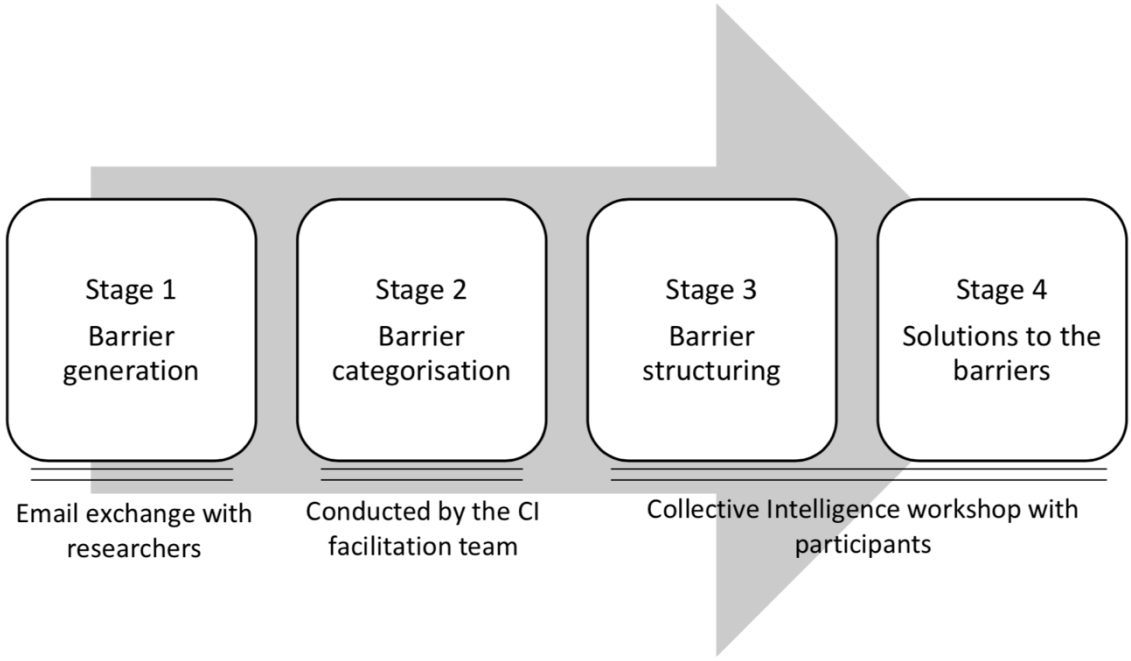
Create a policy which prioritise PE as core subject to curriculum by which schools are measured by and promote it

Establish appropriate evaluation techniques to identify the efficacy and sustainability of programmes

Develop and implement policy to put child health and development at the forefront by increasing the importance of PE in schools and directing appropriate funding and resources to local councils to build and deliver

Build sufficient evidence base to support the greater provision for PE and FMS

Develop structures to ensure sustainability of programmes



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726 **Figure 1 The four stages of the Collective Intelligence consultation**

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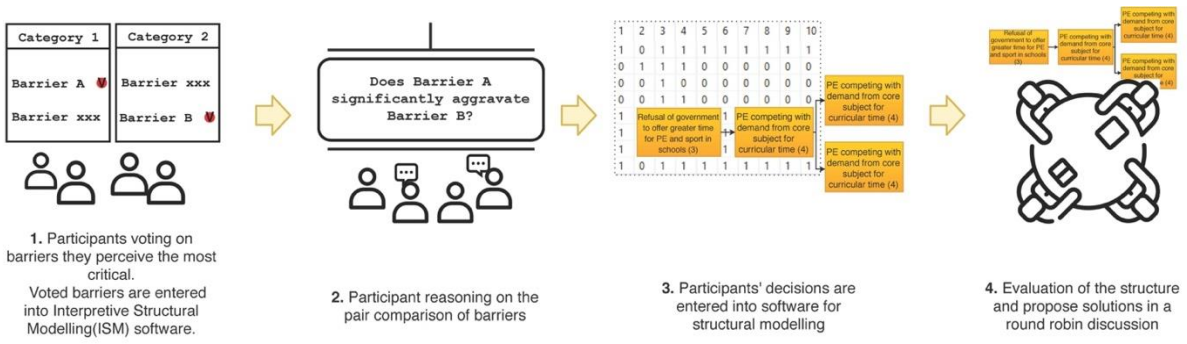

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730 **Figure 2. A simple visual description of key steps in the CI workshop**

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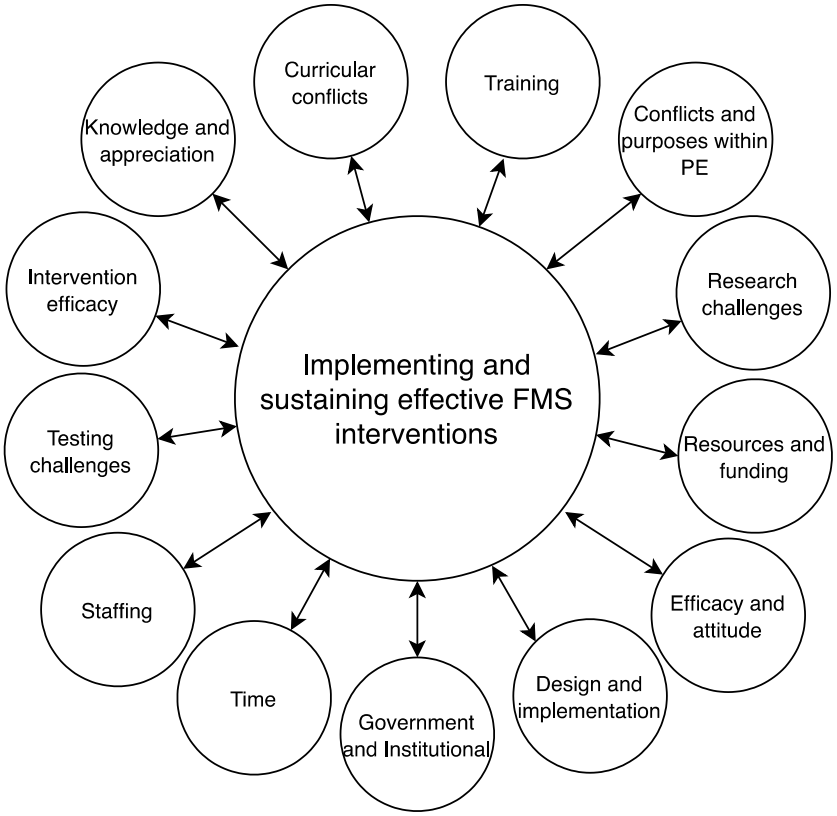

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740 **Figure 3 Barrier categories**

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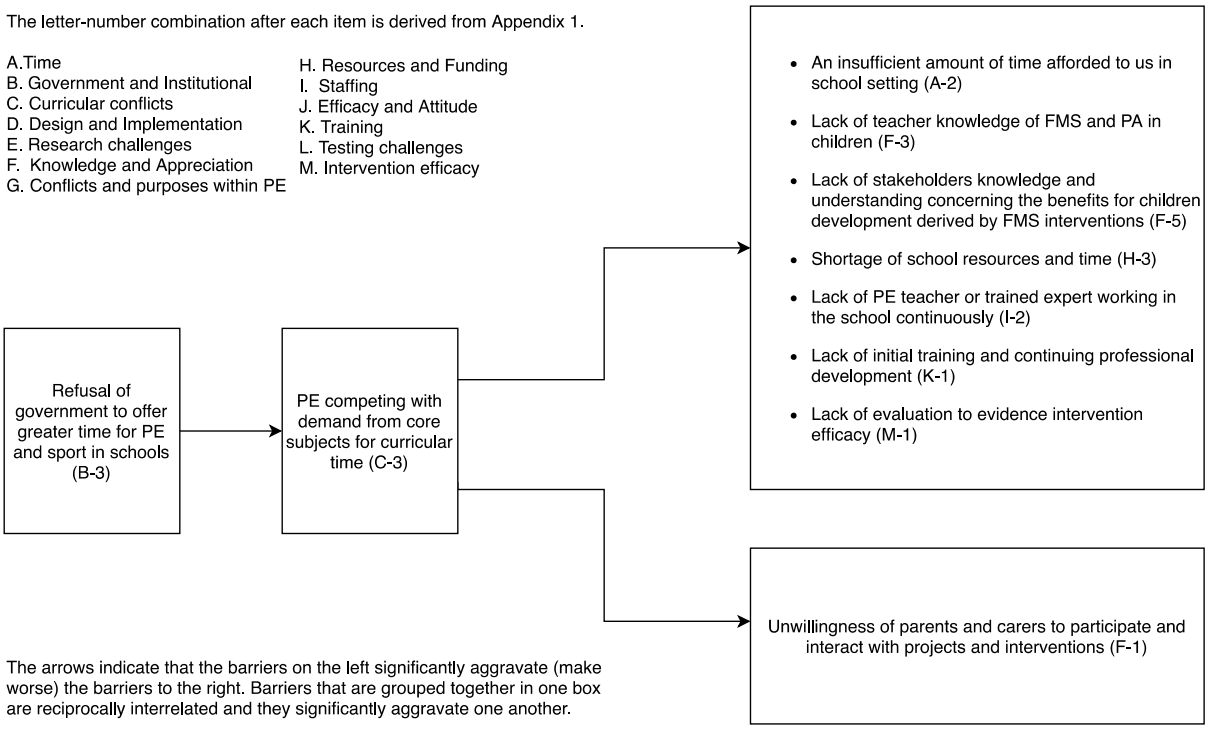

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743 **Figure 4 Example of a structural map from the ISM structuring.**

744 **Table 1 Perspectives represented by participants mapped onto CI prerequisites**

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Participants required for CI to yield optimal outcomes*	Participants information (n, % of total numbers of participants)
Stakeholder	All participants had experience in FMS research (20, 100%); these researchers also had background knowledge in PE teaching (12, 30%), Health Promotion (2, 10%), Sports coaching (5, 25%), Parenting (1, 5%)
Content specialist	FMS researchers (20, 100%), all had experience in in-field intervention delivery

746 * Based on Warfield (2006), the following groups are needed to reach the optimal outcome of CI: a) Stakeholders
747 who have a stake in the issues being considered (e.g. target group of the intervention); b) Content specialist who
748 has specialised knowledge that is relevant to the issue (e.g. intervention developer and implementer)

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750 **Table 2 Example barriers and options**

Barrier Category	Example barriers	Option(s)
Government and Institutional	Refusal of government to offer greater time for PE and sport in schools	(a) Build sufficient evidence base to support the greater provision for PE and FMS; (b) Set up a task force –multi –education, health to develop, implement and evaluate policy and (c) Promote the evidence/findings from the above task force to change government level policies
Curricular Conflicts	PE competing with demand from core subjects for curricular time	(a) Understand better the school values and ethos to drive shared goals and promote them, and (b) Refine school policies in light of the shared values, ethos and goals through observations, auditing and evaluating.

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